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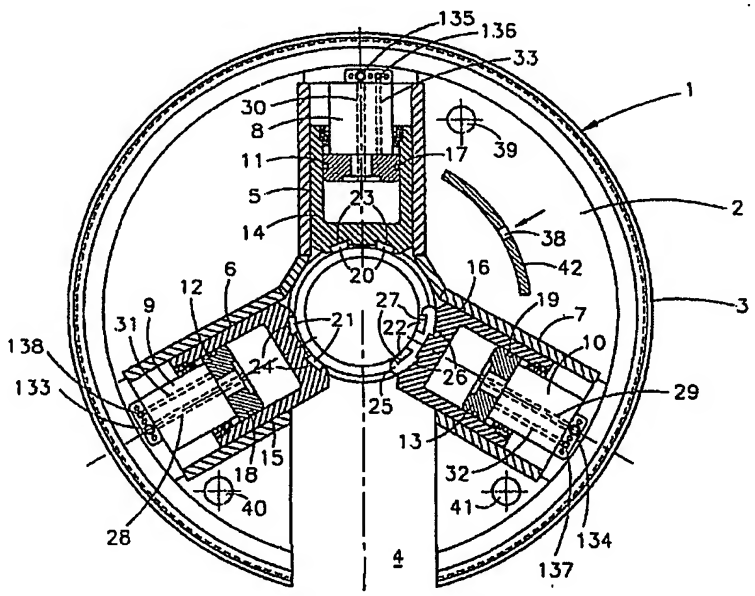

(57) Abstract

This invention relates to a rotary and a method for facilitating the connection of pipes, and more particularly, but not exlusively, to a rotary for a powered drill pipe tong for facilitating the connection of sections or stands of drill pipe to a string of drill pipe.

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POWER TONG

This invention relates to a rotary and a method for facilitating the connection of pipes, and more particularly, but not exclusively, to a rotary for a powered drill pipe tong for facilitating the connection of sections or stands of drill pipe to a string of drill pipe.

Drill pipe tongs are commonly used for facilitating the connection of sections or stands of drill pipe to a pipe string. Typically, the pipe string hangs in a wellbore from a spider in a floor of an oil or gas rig.

A section or stand of drill pipe to be connected to the pipe string is swung in from a drill pipe rack to the well centre above the pipe string. A pipe handling arm may be used to guide the drill pipe to a position above the pipe string. A stabbing guide may then be used to align a threaded pin of the drill pipe with a threaded box of the pipe string. A drill pipe tong is then used to tighten the connection to a torque of typically 68,000Nm (50,000lb.ft).

The drill pipe tong is also used for disconnecting drill pipe. This operation involves breaking the connection which requires a torque typically greater than the tightening torque which may typically be in the order of 110,000Nm (80,000lb.ft).

A drill pipe tong generally comprises jaws mounted in a rotary which is rotatably arranged in a housing. The jaws are moveable relative to the rotary in a generally radial direction towards and away from an upset part of the pipe to be gripped. The upset parts of the pipe are generally located above the pin and below the box of the pipe and have an enlarged outer diameter and/or a reduced inner diameter.

In use, the rotary is rotated forcing the jaws along

cam surfaces towards the upset part of the section of pipe. Once the jaws fully engage the upset part, the rotary carries on rotating applying torque to the threads and hence tightens the connection between the section of pipe and the pipe string.

Several problems have been observed with such prior art drill pipe tongs.

In particular, such drill pipe tongs can badly scar the upset part of the pipe, particularly if the jaws start rotating relative to the drill pipe.

Once scarred, the pipe is then lowered into the wellbore. Friction between the wellbore (or casing lining the wellbore) and the scarred upset grinds the upset, reducing the diameter.

Scarring of the upset may also be caused by having to reapply the jaws. This is especially common when connecting pipe with "wedge threads" which requires approximately 80° of turn in order to toque the connection. Many prior art wrenching tongs need to be reapplied to the pipe every 25°.

A reduction in diameter of the upset requires the use of a new drill pipe tong or for the old drill pipe tong to be modified therefor.

An attempt at solving this problem is disclosed in PCT Publication Number WO 92/18744, which discloses a rotary comprising hydraulically operated active jaws and stationary passive jaws. The hydraulically activated jaws are engaged fully with the pipe prior to rotation of the rotary, thereby substantially reducing scarring. A hydraulic circuit is provided on the rotary for actuating the jaws. A plunger is used to activate the hydraulic system by depressing a hydraulic piston of the hydraulic circuit repeatedly. This operation takes time. If several seconds can be saved per connection, the overall cost of the construction of an oil or gas well can be drastically

reduced, as long as reliability is not sacrificed.

Another problem associated with the rotary disclosed in PCT Publication Number WO 92/18744 is that repeated depressing of the plunger for engaging the jaws fully with the pipe may itself cause some scaring.

According to a first aspect of the invention, there is provided a rotary comprising at least one jaw and means for displacing said at least one jaw, characterised in that said means is actuable by or connectable to pneumatic fluid.

Preferably, said pneumatic fluid is supplied from a supply external to said rotary.

Advantageously, said supply is connectable to said rotor by a coupling.

Preferably, said at least one jaw is displaceable on a piston.

Advantageously, said means for displacing said at least one jaw comprises a hydraulic circuit.

Preferably, said hydraulic circuit comprises a hydraulic pump driven by said pneumatic fluid.

Advantageously, said hydraulic circuit comprises a bellows which, in use may be used to pressurise said hydraulic circuit.

Preferably, said hydraulic circuit comprises an accumulator, which in use, is used to displace said at least one jaw.

Advantageously, said rotary comprises three jaws, all of which are displaceable by said means.

There is also provided a method for facilitating the connection of pipes using the rotary of the first aspect of the invention, the method comprising the step of applying pneumatic fluid to said means to displace said at least one jaw.

* * *

According to a second aspect of the invention, there

is provided a rotary comprising at least one jaw and hydraulic fluid in a hydraulic circuit for displacing said at least one jaw, characterised in that said rotary comprises a pump for pumping said hydraulic fluid through said hydraulic circuit.

Preferably, said at least one jaw is displaceable on a piston.

Advantageously, said pump is drivable by a pneumatic fluid.

Preferably, said rotary further comprises an accumulator, which in use is charged by said hydraulic pump for displacing said at least one jaw. The accumulator may be used for disengaging the at least one jaw from a pipe and/or for engaging the at least one jaw with a pipe.

There is also provided a method for facilitating the connection of pipes using the rotary of the second aspect of the invention, the method comprising the step of pumping hydraulic fluid through said hydraulic circuit to displace said at least one jaw.

* * *

The rotary disclosed in PCT Publication Number WO 92/18744 comprises an accumulator for maintaining full engagement of said jaws with a pipe in case of any leaks or movement of the jaws. A similar device is used in the specific embodiment of the present invention, but is referred to as a bellows.

* * *

According to a third aspect of the invention, there is provided a rotary comprising at least one jaw and means for displacing said jaw characterised in that said rotary comprises an accumulator for storing a charge for displacing said jaw. The accumulator may be used to displace said at least one jaw for disengaging a pipe or engaging a pipe. The accumulator may comprise a hydraulic

accumulator or any other form of energy storage device, for example a spring or an electrical accumulator (not recommended).

Preferably, said at least one jaw is displaceable on a piston.

Advantageously, said means for displacing said jaws comprises a hydraulic circuit.

Preferably, said hydraulic circuit comprises a pump for charging said accumulator.

Advantageously, said pump is drivable by said pneumatic fluid.

Preferably, said accumulator is provided with a check valve arranged in series, such that said accumulator may be charged therethrough inhibiting said accumulator discharging.

Advantageously, said accumulator is provided with a release valve arranged in series therewith, such that upon actuation of said release valve said charge discharges from said accumulator to displace said at least one jaw.

Preferably, said release valve is provided with at least a second release valve arranged in parallel therewith.

There is also provided a method for facilitating the connection of pipes using the rotary of the third aspect of the invention, the method comprising the step of charging said accumulator and using said charge to displace said at least one jaw.

* * *

Another problem associated with the rotary disclosed in PCT Publication Number WO 92/18744 is that disengagement of the jaws is carried out by relieving the pressure of the hydraulic fluid in the hydraulic circuit and moving the jaws from engagement with a pipe manually.

According to a forth aspect of the invention there

is provided a rotary comprising at least one jaw and means for moving said jaw into engagement with a pipe, characterised in that there is also provided power operable retracting means for retracting said at least one jaw.

Preferably, said at least one jaw is displaceable on a piston.

Advantageously, said retracting means comprises an accumulator.

Preferably, said means for displacing said at least one jaw comprises a hydraulic circuit.

Advantageously, said hydraulic circuit comprises a pump for charging said accumulator.

Preferably, the accumulator is located in said rotary.

There is also provided a method for facilitating the connection of pipes using the rotary of the forth aspect of the invention, the method comprising the step of operating said disengagement means for disengaging said at least one jaw from a pipe.

* * *

Another problem associated with the rotary disclosed in PCT Publication Number WO 92/18744 is that the hydraulic circuit arranged on the rotary comprises a reservoir which is open to the ambient air and may allow hydraulic fluid to leak therefrom.

According to a fifth aspect of the invention there is provided a rotary comprising at least one jaw and hydraulic fluid in a hydraulic circuit for displacing said jaw characterised in that said hydraulic circuit is sealed. No hydraulic fluid is open to air.

Preferably, said hydraulic circuit comprises a bellows for containing hydraulic fluid.

For a better understanding of the invention, reference will now be made, by way of example, to the accompanying drawings, in which:

Figure 1 is a top plan view of a rotary of a drill pipe tong in accordance with the invention with parts shown in cross-section; and

Figure 2 is a schematic of a part hydraulic, part pneumatic circuit used in the rotary of Figure 1;

Referring to Figure 1 there is shown a rotary which is generally identified by reference numeral 1.

The rotary 1 comprises a rigid housing 2 which is provided with a toothed perimeter 3 for engagement with toothed drive wheels in a stator of the drill pipe tong (not shown). The housing 2 is also provided with an opening 4 for receiving a drill pipe.

Three piston and cylinders 5, 6 and 7 are arranged about the rotary 1 spaced at 120° to each other and are directed to the centre of the rotary 1. The piston and cylinders 5, 6 and 7 comprise pistons 8, 9 and 10 each provided with a piston head 11, 12 and 13. Cylinders 14, 15 and 16 are slidable along said piston heads 11, 12 and 13 towards and away from the centre of the rotary 1. Sealing rings 17, 18 and 19 are provided in the piston heads 11, 12 and 13 between the piston heads 11,12 and 13 and the cylinders 14, 15 and 16.

Cylinders 14, 15 and 16 are provided with jaws 20, 21 and 22 for engaging with the upset of a drill pipe. The jaws 20 and 21 are located in corresponding dovetail slots 23 and 24. The cylinder 16 is shown provided with an extension member 25 between the cylinder 16 and the jaws 22. The extension member 25 is located in dovetail slots 26 and the gripping elements 22 are located in corresponding dovetail slots 27 in the extension member 25. In use, either all of the cylinders 14, 15 and 16 are provided with extension members 25 or none of the

cylinders 14, 15 and 16 are provided with extension members 25.

Hydraulic lines 28, 29 and 30 and hydraulic lines 31, 32 and 33 are arranged in each piston 8, 9 and 10 for the provision of hydraulic fluid in front of and behind the piston heads 11, 12 and 13.

A quick release pneumatic fluid supply connection 38, an accumulator switch 39 and two release switches 40 and 41 are arranged on the housing 2.

The quick release pneumatic fluid supply connection 38 is slidably arranged in a slot 42 in the housing 2. The slot 42 is shaped to be concentric with the perimeter of the rotary 1. This allows the rotary 1 to rotate a few degrees with a pneumatic fluid supply line attached.

The release switches 40 and 41 are arranged on opposite sides of the rotary so that, when release of the gripping elements 20, 21 and 22 from the drill pipe is required, at least one will be within easy reach of an operator. In particular, in use, part of the stator of the drill pipe tong (not shown) may obscure use of one of the release switches.

Referring now to Figure 2 there is shown a circuit which is generally identified by reference numeral 100 arranged in and on the housing 2 of the rotary 1.

The circuit 100 is provided with a quick release pneumatic fluid connection 38 slidably arranged in slot 42 of the housing 2 of the rotary 1. The pneumatic fluid is supplied from a source 101 via hose 102, through a valve 103 and through hose 104 to the connection 38. The source supplies pneumatic fluid at approximately 10 bar. A pneumatic line 105 in the housing 2 divides into two branch lines 106 and 107 supplying a pneumatic pump 108 and a bellows 109 respectively. Pneumatic line 107 comprises an valve 110 which is biased by spring 111 to an open position to allow pneumatic fluid to flow to

bellows 109.

The circuit 100 is charged while the drill pipe tong is situated away from the drill pipe. This step is carried out by moving the valve 103 to an open position to allow pneumatic fluid to flow from source 101 through pneumatic line 105 and by depressing accumulator switch 39. With the accumulator switch 39 depressed, branch line 107 is blocked. Pneumatic fluid actuates pneumatic pump 108, which pumps hydraulic fluid around a sealed circuit 112.

Hydraulic fluid drawn through line 116 and 117 from the bellows 109 is pumped through line 118, through a check valve 120 into an accumulator 121. A line 119 leads from the rear of check valve 120 to a rear side of spring loaded check valve 122. The spring loaded check valve 122 is biased towards a closed position by a spring 123. A control line 124 leads from a rear side of the spring loaded check valve 122, in parallel with spring 123.

Since accumulator switch 39 is depressed hydraulic fluid is prevented from being pumped through line 113 by the valve 114 being in a closed position.

Hydraulic fluid is prevented from being pumped through a control line 124 by release valves 40, 41 which are closed and by a check valve 125. Hydraulic fluid is also prevented from being pumped through control line 126 by the check valve 125.

The check valves 120 and 125 inhibit high pressure hydraulic fluid escaping from the accumulator 121.

Control line 126 leads from a front side of the check valve 125 to the rear side of a spring loaded check valve 127 in parallel with a spring 128 which bias the spring loaded check valve 127 to a closed position.

Pneumatic fluid 129 in the accumulator 121 is compressed by the pneumatic pump 108 to approximately 280 bar. The pump 108 is prevented from overloading the

accumulator by being designed to stall at 280 bar or by use of a pressure relief valve (not shown). The supply of pneumatic fluid is stopped by closing the valve 103. The accumulator switch 39 is now released.

The drill pipe tong can now be offered up to the drill pipe (not shown). The drill pipe is located between the jaws 20, 21 and 22 of the rotary 1 through the opening 4.

The jaws 20, 21 and 22 are activated to engage the upset of the drill pipe by opening the valve 103. Pneumatic fluid flows through the valve 103, through line 105 into line 106 and drives the pump 108 and also through line 107 to one side of a membrane 130 in bellows 109, squeezing hydraulic fluid to the cylinders 14, 15 and 16 at a high flow rate. Hydraulic fluid pressure acting against spring 128 of the spring loaded check valve 127 opens the spring loaded check valve 127. A small amount of hydraulic fluid is allowed to seep from line 126 past the ball of the spring loaded check valve 122 as it opens.

The pump 108 pumps hydraulic fluid into line 113 through valve 114 into line 131, through a check valve 132 and into the cylinders 14, 15 and 16 via branch lines 133, 134 and 135. The pump 108 draws hydraulic fluid from the bellows 109 and from behind the piston heads 11, 12 and 13 through lines 136, 137 and 138, through device 139, through lines 141, 142 into line 140 and through line 143 into line 144 via a flow diverter 145, into line 116 into pump 108. The jaws 20, 21 and 22 engage the pipe. The pump 108 will stall or is stopped by removing the pneumatic fluid once the desired engaging force has been reached. This is typically when the pressure in the circuit 100 has built up to 280 bar.

It should be noted that, during this procedure, the accumulator 121 is simultaneously brought up to the same

pressure as the engaging pressure if it does not already retain a pressure equal to or higher than the engaging pressure.

The flow diverter 145 is biased to allow fluid communication between lines 143 and 144. The device 140 comprises three rotors 146, 147 and 148 arranged on a common shaft 149. When hydraulic fluid flows through the rotors 146, 147 and 148, the rotors allow equal volumes of fluid to pass, thereby ensuring even movement of the jaws 20, 21 and 22 arranged on the cylinders 14, 15 and 16.

The hose 104 may now be disconnected from the connection 38.

The rotary 1 may now be rotated to rotate the drill pipe to connect drill pipe.

Once rotation has ceased, the jaws 20, 21 and 22 are disengaged and retracted from the drill pipe. This is carried out by pressing one or both of the release valves 40, 41. This allows hydraulic fluid to flow from the accumulator 121 through control line 124, through spring loaded check valve 122 and through release valves 40 and/or 41 into line 115, line 116 and line 117 to bellows 109. A small amount of hydraulic fluid is allowed to seep past the ball of the spring loaded check valve 122. Hydraulic fluid under pressure also flows from control line 126, allowing pressurised hydraulic fluid to flow from infront of the piston heads 11, 12 and 13 to bellows 109. High pressure hydraulic fluid shifts the flow diverter 145, allowing high pressure hydraulic fluid to flow into line 143. The flow through line 143 rotates the rotor 147, which rotatably drives rotors 146 and 148 via shaft 149 and sucks hydraulic fluid out of bellows 109 into the cylinders behind the piston heads 11, 12 and 13 and retracts the jaws 20, 21 and 22 in unison. A valve 150 is arranged in parallel with line 143 and bypasses

the device 139. The valve 150 is biased by a spring 151 to a closed position, however upon the pressure increasing on the rear side of the piston head 12, the valve 150 opens equalling the flow rate between the driving rotor 147 and the driven rotors 146 and 148.

The hydraulic fluid in front of the piston heads 11, 12 and 13 is expelled through branch lines 133, 134 and 135 into line 131a and passes through spring loaded check valve 128 into line 117 and into bellows 109. The residual hydraulic fluid due to the difference in volumes of the cylinders 14, 15 and 16 when engaged and retracted, flows is stored in the bellows 109.

Restrictors 152 and 153 inhibit sudden changes in pressure upon depression of the release valve 40, 41 and the opening of spring loaded check valve 122. A safety release valve 155 is provided such that if pressure in the accumulator 121 needs to be released the safety valve can be operated to vent the hydraulic fluid to atmosphere or into a safety release accumulator 156. The safety release valve may be operated by a control or be a removable cap 157 in a block 200.

The valves 120, 122, 125, 127, 132, 145, 155 and the respective lines and control lines are arranged in a single block 200. The block 200 may be any suitable material such as aluminium, aluminium alloys or steel.It should be noted that the entire circuit 100 is arranged in or/and on the rotary 1. The pneumatic fluid source 101 is of the type provided on most drilling rigs and is typically at a pressure of 10 bar.

Various modifications are envisaged to the above apparatus. In particular, it is envisaged that a further accumulator could be provided for providing a charge for moving the jaws into engagement with a pipe. This has the advantage that the pneumatic fluid line may be removed from the drill pipe tong before the drill pipe

tong is moved about the pipe thus saving vital seconds disconnecting the hose from the rotary.

It is also envisaged that the apparatus could be used with thin walled pipe, as it is relatively simple to alter the force applied to the pipe by the jaws.

It is also envisaged that the accumulator could take the form of a spring or a battery.

Claims

1. A rotary comprising at least one jaw (20,21,22) and means (100) for displacing said at least one jaw (20,21,22), characterised in that said means (100) is actuable by or connected to a pneumatic fluid.

2. A rotary as claimed in Claim 1, wherein said pneumatic fluid is supplied from a supply external to said rotary.

3. A rotary as claimed in Claim 2, wherein said supply is connectable to said rotary by a coupling.

4. A rotary as claimed in Claim 1, 2 or 3, wherein said at least one jaw (20,21,22) is displaceable on a piston (11,12,13).

5. A rotary as claimed in any preceding claim, wherein said means (100) for displacing said at least one jaw (20,21,22) comprises a hydraulic circuit.

6. A rotary as claimed in Claim 5, wherein said hydraulic circuit (100) comprises a hydraulic pump (108) driven by said pneumatic fluid.

7. A rotary as claimed in Claim 5 or 6, wherein said hydraulic circuit comprises a bellows (109) which, in use maintains pressure in said hydraulic circuit (100).

8. A rotary as claimed in Claim 5, 6 or 7, wherein said hydraulic circuit (100) comprises an accumulator (121), which in use, is used to displace said at least one jaw (20,21,22).

9. A rotary as claimed in preceding claim, wherein said rotary comprises three jaws (20,21,22), all of which are displaceable by said means (100).

10. A method for facilitating the connection of pipes using the rotary as claimed in any preceding Claim, wherein the method comprises the step of applying pneumatic fluid to said means to displace said at least one jaw.

* * *

11. A rotary comprising at least one jaw (20,21,22) and hydraulic fluid in a hydraulic circuit (100) for displacing said at least one jaw (20,21,22), characterised in that said rotary further comprises a pump (108) for pumping said hydraulic fluid through said hydraulic circuit (100).

12. A rotary as claimed in Claim 11, wherein said at least one jaw (20,21,22) is displaceable on a piston (11,12,13).

13. A rotary as claimed in Claim 11 or 12, wherein said pump (108) is drivable by a pneumatic fluid.

14. A rotary as claimed in Claim 11, 12 or 13, wherein said rotary further comprises an accumulator (121), which in use is charged by said hydraulic pump (108) for displacing said at least one jaw (20,21,22).

15. A method for facilitating the connection of pipes using the rotary as claimed in any of Claims 11 to 14, the method comprising the step of pumping hydraulic fluid through said hydraulic circuit to displace said at least one jaw.

* * *

16. A rotary comprising at least one jaw (20,21,22) and means for displacing said at least one jaw (20,21,22), characterised in that said rotary comprises an accumulator (121) for storing a charge for displacing said jaw.

17. A rotary as claimed in Claim 16, wherein said at least one jaw (20,21,22) is displaceable on a piston (11,12,13).

18. A rotary as claimed in Claim 16 or 17, wherein said means for displacing said at least one jaw (20,21,22) comprises a hydraulic circuit (100).

19. A rotary as claimed in Claim 16, 17 or 18, wherein said hydraulic circuit (100) comprises a pump (108) for charging said accumulator (121).

20. A rotary as claimed in Claim 19, wherein said pump (108) is drivable by said pneumatic fluid.

21. A rotary as claimed in any of Claims 16 to 20, wherein said accumulator (121) is provided with a check valve (120) arranged in series, such that said accumulator (121) may be charged therethrough inhibiting said accumulator (121) discharging.

22. A rotary as claimed in any of Claims 16 to 21, wherein said accumulator (121) is provided with a release valve (40,41) arranged in series therewith, such that upon actuation of said release valve (40,41) said charge discharges from said accumulator (121) to displace said at least one jaw (20,21,22).

23. A rotary as claimed in Claim 22, wherein said release valve (40,41) is provided with at least a second release valve (40,41) arranged in parallel therewith.

24. A method for facilitating the connection of pipes using the rotary as claimed in any of Claims 16 to 23, the method comprising the step of charging said accumulator (121) and using said charge to displace said at least one jaw (20,21,22).

* * *

25. A rotary comprising at least one jaw (20,21,22) and means for moving said jaw into engagement with a pipe, characterised in that there is also provided power operable retracting means (121) for retracting said at least one jaw (20,21,22).

26. A rotary as claimed in Claim 25, wherein said at least one jaw (20,21,22) is displaceable on a piston (11,12,13).

27. A rotary as claimed in Claim 25 or 26, wherein said power operable retracting means (121) comprises an accumulator.

28. A rotary as claimed in Claim 25, 26 or 27, wherein said means for displacing said at least one jaw

(20,21,22) comprises a hydraulic circuit (100).

29. A rotary as claimed in Claim 28, wherein said hydraulic circuit (100) comprises a pump (108) for charging said accumulator (121).

30. A rotary as claimed in Claim 29, wherein the accumulator (121) is located in said rotary.

31. A method for facilitating the connection of pipes using the rotary as claimed in any of Claims 25 to 30, the method comprising the step of operating said power operable retracting means for retracting said at least one jaw from a pipe.

* * *

32. A rotary comprising at least one jaw (20,21,22) and hydraulic fluid in a hydraulic circuit (100) for displacing said jaw, characterised in that said hydraulic circuit (100) is sealed.

33. A rotary as claimed in Claim 32, wherein said hydraulic circuit (100) comprises a bellows (109) for containing hydraulic fluid.

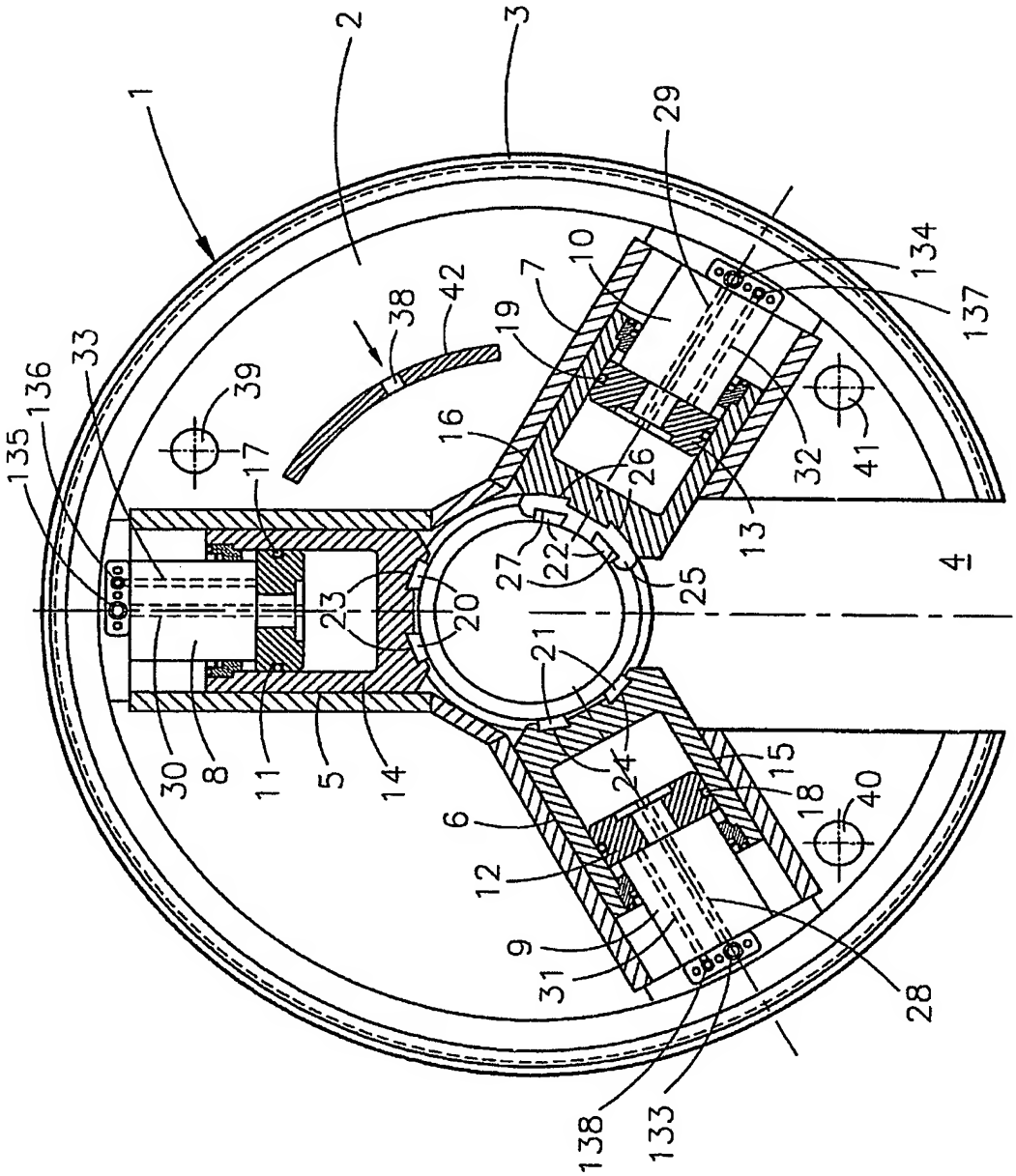
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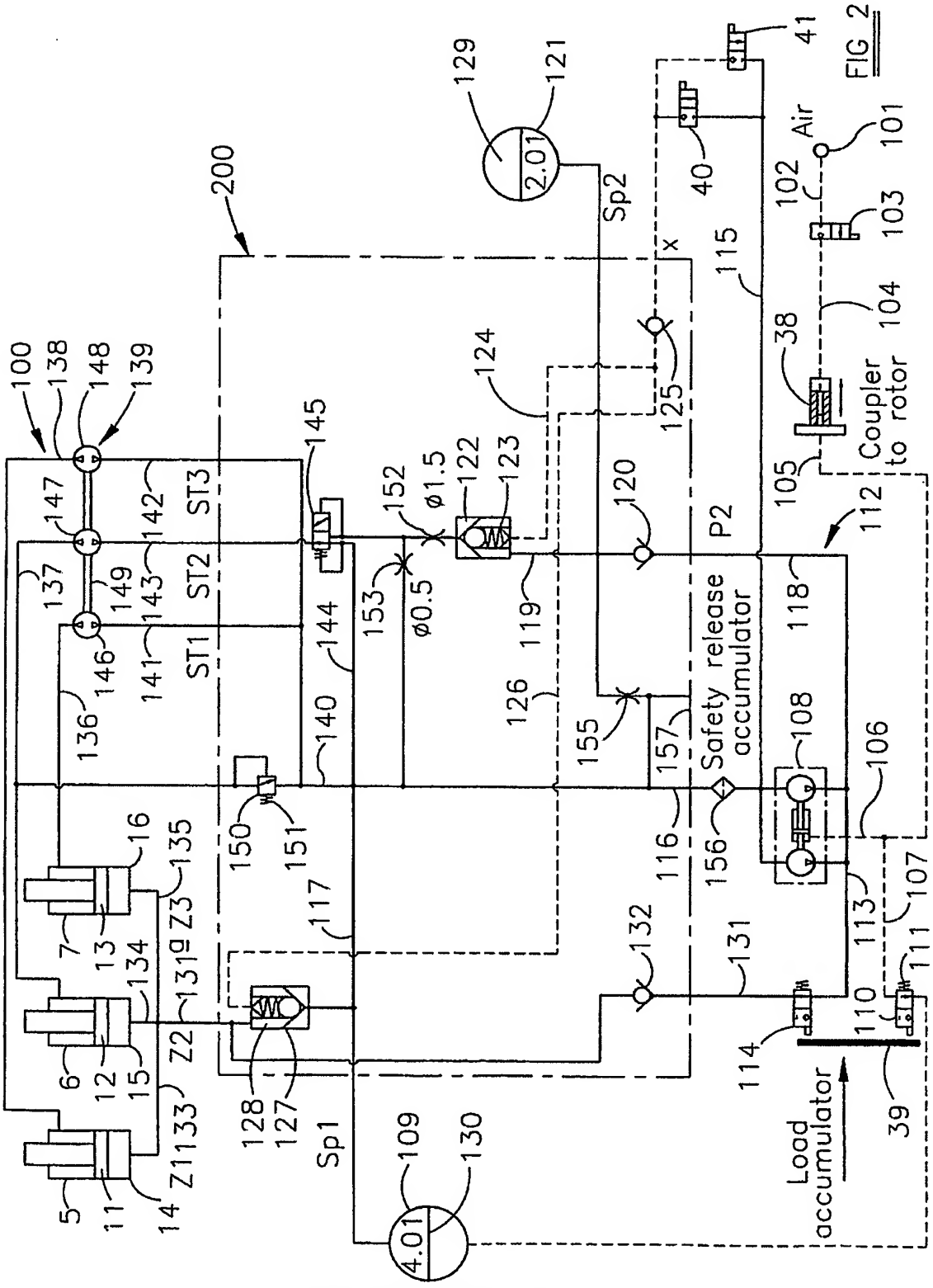
FIG 1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Z2
Z1
6
12
15
133
5
11
14
128
127
Sp1
109
130
4.01
129
121
2.01
Sp2
x
115
41
40
Air
102
101
103
104
38
Coupler to rotor
105
39
Load accumulator

FIG 2

INTERNATIONAL SEARCH REPORT

Inter nal Application No
PCT/GB 99/04448

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 E21B19/16

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 E21B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 95 20471 A (CANRIG DRILLING TECH LTD) 3 August 1995 (1995-08-03) page 3, line 13 -page 4, line 7 page 5, line 1 -page 8, line 18 figure 6	1,4-6,8, 10-20, 22,24-32
Y		9
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☐ Further documents are listed in the continuation of box C.

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16 March 2000	27/03/2000

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European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Schouten, A

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INTERNATIONAL SEARCH REPORT

information on patent family members

Inter: nal Application No
PCT/GB 99/04448

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